REARING AND DEVELOPMENT OF *PHYLLOCOPTES FRUCTIPHILUS* (ACARI:ERIOPHYIDAE)[1,2]

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ABSTRACT: A mass rearing program for *Phyllocoptes fructiphilus*, the eriophyid vector of rose rosette disease, was developed. The mites inhabit shoot tips and leaf petiole bases of several varieties of roses. A rearing arena, allowing observation of individual mites, was designed. Developmental periods for life stages, and wintering form and sites are reported.

Rose rosette disease (RRD) is a disease of many wild and domestic roses, especially *Rosa multiflora* Thunb. It was orginally described and reported from western states and Canada (Thomas and Scott 1953) and more recently from midwestern states (Allington *et al.* 1968, Crowe 1982, Gergerich and Kim 1983, Hindal and Amrine 1987, 1989). It also is known from Ohio in 1988 and West Virginia in 1989 (Amrine, unpublished).

Rose rosette disease is transmitted by the eriophyid mite, *Phyllocoptes fructiphilus* Keifer (Allington *et al.* 1968, Amrine *et al.* 1988, Gergerich and Kim 1983). Little is known about the mite's biology, but its life history is thought to be similar to that of other eriophyids (Allington *et al.* 1968). It lives and breeds in protected areas between leaf petiole bases and lateral buds, within small developing leaflets and particularly on the tips of rapidly growing shoots. Many eriophyids that overwinter as adults are known to develop deuterogynous females. However, none have been reported for this species. Conventional methods of rearing individual eriophyid mites (Rice and Strong 1962, Tashiro 1967, Slykhuis 1969) proved unsatisfactory for *P. fructiphilus*, since the mite could not feed and breed satisfactorily. Also, rearing large colonies in the greenhouse was not possible because spider mites generally invade and must be controlled.

This paper describes a reliable method for rearing large colonies of *P. fructiphilus* and a chamber for observation of individual mites. Life history data are also reported.

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MATERIALS AND METHODS

Large colonies of mites were maintained year-round on potted *R. multiflora* plants in illuminated rearing stands. Each rearing stand was constructed of wood 5x10 cm (2″x4″s) with dimensions of 1.2x0.8x2.3 m to accommodate two shelves, one at the bottom and one at the center (Figure 1). Lighting for each shelf consisted of five pairs of 1.2m fluorescent tubes (40 W each), three pairs at the top (1.1m above each shelf) and one on each side, and six incandescent lights (100 W each) in two rows of three each at the top between the fluorescent tubes. Each shelf had a separate switch and timer for each type of light.

Large *R. multiflora* were dug, pruned to the crown, potted in sterilized soil medium, placed on the stands, and maintained at 16L:8D under fluorescent lights. Incandescent lights were used for 4 hrs in mid-photoperiod to stimulate mid-day higher temperatures (33°C) and light intensity. Temperature ranged from 27°C to 33°C and relative humidity averaged 45%. The plants were artificially infested with noninfected *P. fructiphilus* obtained from *R. multiflora* in Morgantown, WV, and with RRD-infected mites from *R. multiflora* in Madison, IN. Noninfected and RRD-infected colonies were kept in separate rooms and mites were regularly identified to insure species purity. Special precautions were taken to assure exclusion of spider mites: trimming plants to two or three canes 15-20 cm long; spraying these basal canes with spraymount to trap any attached mites; and restricting entry, especially if person(s) had visited the greenhouse.

To rear and observe individual mites, a 12x12 mm plastic coverslip (0.17-0.25 mm thick) was cut into four, 6x6 mm sections, and a 3 mm diameter hole was punched into the center of each section. The 6x6 mm section was cemented to a young host plant leaflet using Elmers Glue-All (Figure 2). An egg or female *P. fructiphilus* was placed in the arena, and a circular, 12 mm diameter glass coverslip (0.13-0.17 mm thick), treated with Spritz anti-fog spray, placed on top. Each leaf with arenas and damp facial tissue around the leaf base was then placed on damp filter paper in a petri dish and maintained at 16L:8D under fluorescent lights. Test leaves were maintained at room temperature (23±1°C).

To determine the duration of each life stage, younger leaves from healthy multiflora rose were prepared with 5-10 arenas, depending on leaf size (Figure 3). For each trial of three replicates, 20 adult mites (live mites can not be sexed, but males made up only 10-30% of population (Amrine, unpublished)) were placed singly in separate arenas. Adults were removed after egg depositon. Eggs were checked at 6-hr intervals, and emerging larvae were transferred to separate arenas (one per arena) on fresh leaves. The number of stages and time required for each

Figure 1. An illuminated rearing stand.

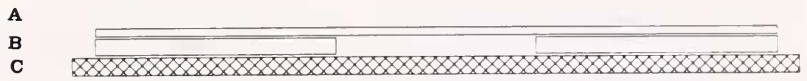

Figure 2. Cross section of a rearing arena (12X). A, coverslip treated with anti-fog; B, plastic coverslip with 3 mm diameter hole in center; C, host plant leaflet.

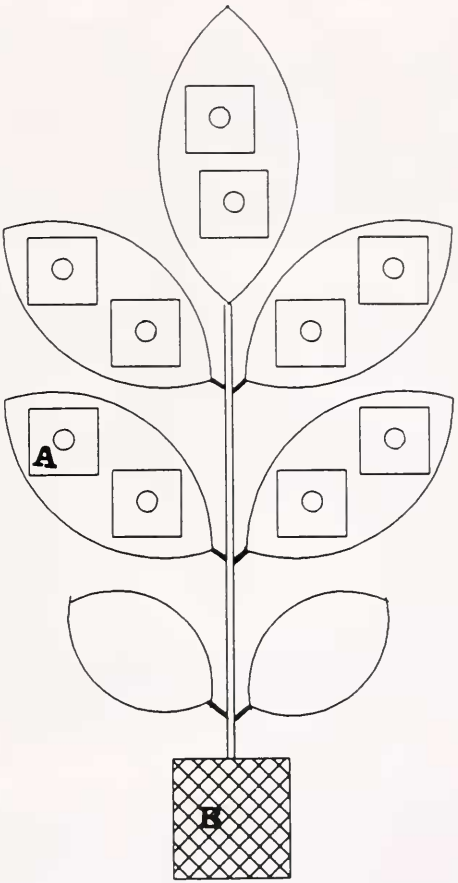

Figure 3. The arrangement of individual arenas on a host leaf. A, arena; B, damp tissue.

developmental period were recorded.

To determine wintering stages and sites, plant material was collected in December 1988 at Madison IN from plants known to have been infested with *P. fructiphilus* and returned to the lab and kept in 5°C refrigerator to be examined thoroughly for over-wintering mites.

RESULTS AND DISCUSSION:

Mite Rearing. The rearing stands produced good growth of multiflora rose plants and supported large colonies of *P. fructiphilus* which lasted for about 3-4 months under these conditions. The rearing arena was successful in caging all stages of mites, for observation. However, most adult *P. fructiphilus* moved about and climbed the arena wall and onto the coverslip. Adults apparently fed little and survival was low; this is reflected in the scarcity of adult data in Table 1. The low acceptance of arena habitus by adult mites probably reflects their preference for rapidly growing shoot tips.

Life Cycle. *Pl fructiphilus* has a typical eriophyid mite life cycle which consists of egg, protonymph, deutonymph and adult. Development times for each stage are presented in Table 1. Newly laid eggs were transparent and became milky white as they aged. Single eggs were deposited randomly within the feeding arena. The egg stage averaged 4.3 days.

Newly emerged protonymphs were transparent and also became white with age. Protonymphs were active and fed for about 2.4 days before transforming into the stationary, swollen and shiny "phararte" form. Deutonymphs resemble adults in size and shape. As they mature, the color changes from white to yellowish white. They actively move and feed for about 2.5 days before the mities become quiescent, swollen and shiny, pharate forms.

The yellowish white adults are active and start feeding almost immediately after emerging. Females start laying eggs within 12-24 hrs. after emergence. In our study, females laid an average of 1 egg/day for the first few days and then no eggs for the remainder of the adult stage, a period which varied from 10 to 50% fo their life span producing an average of 0.64 eggs/day (Table 2).

Hibernation Sites. Examination of whole branches in December revealed an orange form of the mite which had been noticed in field populations during the 1987 and 1988 seasons. This form is thought to represent either a facultative change in color and shape as a response to adverse conditions, or it may be a deutogyne. Aside from the orange color and more trapezoidal shape, there were no obvious anatomical differences from typical *P. fructiphilus* to support a deutogyne desig-

Table 1. Life stage intervals for *Phyllocoptes fructiphilus*

Stage	N	Mean Duration (days)	Range
egg	37	4.31±0.16	1.29-6.04
Protonymph	31	3.29±0.13	2.17-4.33
Deutonymph	32	3.29±0.18	1.83-4.63
adult	7	14.14±0.96	6.00-26.00

Table 2. Egg production of *Phyllocoptes fructiphilus* K.

Mite No.	Sex	Days Observed	Total Eggs Laid	Eggs/Day
1	F	6	5	0.83
2	M	26	0	0.00
3	F	16	4	0.25
4	F	7	6	0.86
5	F	16	10	0.63
6	F	14	11	0.79
7	F	14	7	0.50
Mean		14.14	7.17	0.64
Variance		6.64	2.79	0.24
Standard Error		0.97	0.63	0.19

nation (Amrine, unpublished). *P. fructiphilus* wintered in groups or singly in various sheltered places but mostly under bud scales of small lateral buds and occasionally under the loose bark of the previous year's growth.

SUMMARY

A method of rearing *P. fructiphilus* using artificial lighting and transplanted multiflora rose plants proved successful in reducing spider mite infestations and eliminating the need to control spider mites.

A special arena was designed utilizing plastic slide coverslips glued to rose leaflets which allowed study of the life stages from egg to the adult. The average duration of life stages was: egg 4.31 days, first nymph 3.29 days, second nymph 3.29 days and adult 14.14 days.

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LITERATURE CITED

Allington, W.B., R. Staples and G. Viehmeyer, 1968. Transmission of rose rosette virus by the eriophyid mite *Phyllocoptes fructiphilus*. J. Econ. Entomol. 61:1132-1140.

Amrine, J.W., D.F. Hindal, T.A. Stasny, R.L. Williams and C.C. Coffman. 1988. Transmission of the rose rosette disease agent to *Rosa multiflora* by *Phyllocoptes fructiphilus* (Acari:Eriophyidae). Ent. News 99:239-252.

Crowe, F.J. 1982. A recent outbreak of Witches' Broom of rose in eastern Kansas and western Missouri. Phytopath. 72:976-977.

Gergerich, R.C. and K.S. Kim. 1983. A description of the causal agent of rose rosette disease. Arkansas Farm Res. 32: 7.

Hindal, D.F. and J.W. Amrine. 1987. New findings of rose rosette disease. Phytopath. 77:987 (abstract).

Hindal, D.F., J.W. Amrine, R.L. Williams and T.A. Stasny. 1988. Rose rosette disease on multiflora rose (*Rosa multiflora*) in Indiana and Kentucky. Weed Technology *2*: 442-444.

Rice, R.E. and F.E. Strong. 1962. Bionomics of the tomato russet mite, *Vasates lycopersici* (Massee). Ann. Entomol. Soc. Amer. 55:431-435.

Slykhuis, J.T. 1969. Methods for experimenting with mite transmission of plant viruses, pp. 347-368. *In*: K. Maramorosch & H. Koprowski. Methods in Virology, Vol.1, Academic Press. 640 pp.

Tashiro, H. 1967. Self-watering acrylic cages for confining insects and mites on detached leaves. J. Econ. Entomol. 60:354-356.

Thomas, E.A. and C.E. Scott. 1953. Rosette of rose. Phytopathology 43: 218-219.